DOCUMENT RESUME

ED 350 702 EA 024 397

AUTHOR	Willis, Norman
TITLE	New Technology and Its Impact on Educational Buildings.
INSTITUTION	Organisation for Economic Cooperation and Development, Paris (France).
REPORT NO	ISBN-92-64-13756-4
PUB DATE	92
NOTE	50p.
AVAILABLE FROM	OECD Publications and Information Centre, 2001 L Street, N.W., Suite 700, Washington, DC 20036-4910.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Computer Uses in Education; Educational Environment; Educational Facilities; *Educational Facilities Design; *Educational Facilities Planning; Elementary Secondary Education; Foreign Countries; Information Dissemination; School Buildings; *Technological Advancement; *Technology
IDENTIFIERS	*Organisation for Economic Cooperation Development

ABSTRACT

The results of the OECD's recent work on the impact of new technology on educational facilities are presented in this document, which draws particularly on the proceedings of an international seminar held in Rochefort-sur-Mer, France, in June 1991. The introduction identifies issues posed by new technology to educational facility designers and managers, and includes two articles: "Myths and Realities," by Jacques Herbenstreit; and "The Task of Educational Building Designers," by Sam Casseis. The second section summarizes seminar papers with regard to changes in technology, society, education, buildings, and technology-based learning in continuing education and training. Seminar papers and authors are listed. Technological, societal/political, and education/training trends are described in section 3, and the fourth section offers forecasts for buildings, structures, and use of building space. Section 5 provides conclusions pertaining to: the interface between technology, education, and society; changes in the educational structures and methods; and changes in buildings. Adaptability must be built into the system to accommodate the great pace and impact of change as the world moves into a postindustrial, information-based era. Two figures are included. References accompany individual sections. (LMI)

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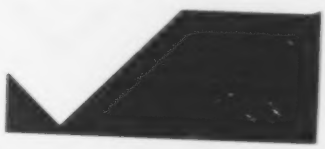

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NEW TECHNOLOGY AND ITS IMPACT ON EDUCATIONAL BUILDINGS

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Publié en français sous le titre :

LES NOUVELLES TECHNOLOGIES ET LEURS INCIDENCES SUR LA CONSTRUCTION SCOLAIRE

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- giving early warning of the impact on educational facilities of trends in education and in society as a whole.

The present report summarises the results of the programme's recent work on the impact of new technology on educational facilities, drawing in particular on the proceedings of an international seminar held in Rochefort-sur-Mer, France, in June 1991. The author, Norman Willis, is formerly Deputy Director of the National Council for Educational Technologies in the United Kingdom. The ideas which are expressed are his own and do not necessarily represent those of the authorities concerned or the OECD.

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I. INTRODUCTION

This section consists of three complementary views of the challenge posed by new technology to educational-facility designers and managers.

i) The subjects for discussion

The person compiling this report is a live example of a "teleworker": someone who works alone at his computer in an office in his own home for an employer three hundred miles away in another country; who uses the telecommunications system to keep in touch with his employer; who sends information to him in computer data form for processing on his own equipment; who is a current example of what will be an increasing trend over the next twenty years.

I point this out because it is important, at the beginning of this report, to understand that the forecasts made are firmly based on things which I know to be happening, or being developed now. There is no science fiction in the forecasts. Indeed the next twenty years may well prove that they have been too conservative.

The picture painted is one of rapid change — technological, societal, environmental and above all educational change. The children of today look upon the world in which their grandparents grew up — a world before television, when very few people owned a car, when only one person in each road had a telephone; the world of fifty years ago — with disbelief. Their children, who will be starting school at the end of the twenty-year period we are considering, will look upon the 1990s with similar disbelief. How are we, whose experience is rooted in circumstances which have passed, and whose day-to-day work is mainly concerned with the urgent problems of today, to think in a constructive way about the implications of changes which will have their full effect in twenty years' time?

The way to cope is to spend a minimum amount of time thinking about the details of possible changes in technology, society and the environment. We may not agree with every aspect of the forecasts about satellite television, or precisely when integrated broad-band telecommunications will become generally available, or even, for example, whether women will form 33 per cent or 45 per cent of the workforce by 2010. What will be the implications for education — and for the provision of spaces in which the learning process can take place — of the changes which are already becoming so apparent?

We must think about ways in which education itself may need to change if it is to fit young people adequately for life in the middle years of the twenty-first century. What sorts of skills will they need? What methods of learning will they need to have experienced so that they can keep on learning throughout their working lives?

We should consider the implications for learning of, for example, the ease with which students will be able to obtain a "second opinion" on any question, in addition to that provided by their teacher or textbook; or of the ease with which work on a word-processed text can be shared between students: whose work will the final version be? and does it matter?

We need to think about teachers. Will they be doing the same sort of work as they are now? What is the status of a person who writes a piece of self-instructional

material: a teacher? an "author"? an "expert"? one of education's "support staff"? Who is the best person to relate to an individual student — a teacher, a tutor, an information provider, an older student, a television presenter? And what does that say about the types of professionals who will be working in the education service, their relationships with each other, and the types and amount of space we shall need to provide for them to work in?

Will there be a massive shift towards more individually tailored education, treating each student as a person with different capabilities and potential, not just as a member of a group, called a "class", defined by age only? One college in the east of England already delivers over 40 per cent of its teaching in some major subjects through an individual, resource-based method. Students at quite early stages of maturity are taking more responsibility for their own progress in learning. What implications does this have for peer-group relations; for their attitudes to, and relations with, teachers and tutors, and with other people — for example librarians — who support the learning process?

The administrative and resource control systems available through computer software will enable this trend to individualisation to be efficiently managed — indeed, there is already a college in north-west England where large numbers of students "drop in" at various times for various parts of courses and are registered and have access to their appropriate learning materials through a computerised "Learning Pass" system. As this type of student-negotiated, open-access learning spreads, what implications will new administrative and educational control procedures have for staffing and space provision?

Such issues highlight a question on which the working groups at the seminar spent a great part of their discussion time: where should learning take place? Will the present concept of "school" or "college" as a place separate from all other social and economic activity continue to be sustainable in a world where learning forms up to 75 per cent of "work"? To what extent can we — should we — maintain the idea of school as a separate geographical entity? The problems are many.

What about community pride in the fine building to which the young of the district travel for their preparation for life? What about the pride of the architect in presenting a building which reflects local culture and provides appropriate spaces for teaching? But what, also, about the cost of buildings which in many cases are occupied for only part of the day and only part of the year; which must last for sixty years or even more until their cost is amortised; and which will, throughout that time, consume as much as 20 per cent of the education budget in upkeep and alteration? We have to consider what proportion of the learning provided for our young people must take place in the building we currently call "school", and what might be the implications of "sharing" spaces.

On the other hand, we have to consider ways in which new technological developments might allow the retention of buildings for learning purposes in remote or rural areas where demographic or budgetary pressures would otherwise lead to their closure. Might such retention have an environmental and societal benefit by making it unnecessary for children to commute by bus or car to a distant school, and at the same time provide a much-needed centre for adult learning in the community, enabling local people to maintain their economic independence? What should we be aiming for in designing such a building, attractive to children and adults alike and dependent, as it must be, more on technological links with the world outside than with professional staff in the building itself?

Such questions lead to consideration on a wider level of technical matters about all the kinds of buildings which we may find ourselves using for learning purposes. These buildings may be a "school", or may, instead, be parts of quite other buildings like public libraries, town halls, community centres or redundant shops or factories which house "local learning centres" (on the lines of the "telecottages" for teleworkers already being set up in Denmark and Sweden), or indeed facilities within large industrial complexes serving to ease the employment of married women.

What sort of image must they give to those entering through their doors? What techniques must be employed to reduce the noise which is inseparable from individualised, open-access learning, and how do we overcome other forms of noise pollution from the use of television, computer printers, and other technology? What will be the relationship between cable within structures and wired or unwired connections within spaces? How are we to cope with the need for frequent access to telecommunications, and if we deal with this through short-distance radio transmission within buildings, what impact will the structure have on the transmission of those signals?

There is much to think about if we are to ensure that the spaces we provide for learning in the future are truly appropriate to the massive changes which are foreseen in the demands on the education and training services of the OECD countries.

ii) Myths and Realities

(by Jacques Hebenstreit)

The introduction of computers in education

As regards the role of New Information Technology (NIT) in education, there has been a notable change in the tone of reports from the absolute optimism of the 1960s to the very critical and somewhat disappointed reactions of recent years. It is important to consider the reasons for this change in attitude, because it is itself part of the problem.

The idea of using computers in education goes back to the early 1960s when one began to see, as a result of B.F. Skinner's theories,[1] teaching machines which were already multimedia in form because they combined a computer, a tape recorder and a slide or film projector. The only equipment which had a commercial existence was the IBM 1500 — but its commercial lifespan was particularly short.

The invention of "shared-time functioning" (the possibility of connecting a large number of terminals to a powerful computer, which then shared the processing power of the latter) led the Control Data Corporation (CDC) to finance the PLATO project (Programmed Logic for Automatic Teaching Operations) of the University of Illinois. PLATO was eventually commercialised by CDC and R. Morris, Vice-President of CDC for computer-assisted education, confidently predicted that by 1985 PLATO would account for half of CDC's turnover.[2] As it turned out, PLATO regularly made a loss and CDC ceased all activity in the field of computer technology several years ago.

It could be said that all the initiatives undertaken to introduce computers in education have turned out to be failures to the extent that the products and the projects lasted only as long as the subsidies which kept them alive. There are several reasons for this:

- The computers were very expensive and because of this, to envisage their general usage in education was completely utopic.

- The projects had a limited life, were limited in scale, and took no account of the teaching profession as a whole.
- The software was very rudimentary, was unattractive to teachers, and still more unattractive to students.

Yet for marketing reasons, this was also the time when a completely mistaken idea, which even today continues to poison everything dealing with NIT in education, was introduced.

In order to ensure acceptance of the use of computers in education, it was necessary to prove that education with computers was price competitive with traditional education. Yet, considering the price of computers at the time, demonstrating this was possible only if the computer replaced that part of education which costs most — the teachers. To achieve this, it would have been necessary to reduce teaching activities to the only thing a computer knows how to do — the syntactical manipulation of characters — which lead to the forging of the axiom: "teaching is the transmission of knowledge".

In the early 1970s the problem took on a new dimension. On the one hand the arrival of mini-computers (at mini prices) and the spread of time-sharing in the computer market made governments of developed countries more aware of the economic impact of computer technology. On the other hand, the growing number of computers in these countries contributed to creating employment in the computer field at a time when western economies were entering a recession and created an additional problem of training.

The Stanford/UNESCO Symposium[3] phrased it well:

> *Countries are increasingly formulating national policies regarding computers in education in response to the growing number of computers being used in the private sector and in response to political pressures of 'national survival' in the face of a worldwide informatics revolution. Such policies are usually necessary to introduce computers in public education because of the relatively high cost involved.*

It is necessary to keep in mind that the massive introduction of computers in education was a political decision made, in every case, without consultation with teachers and in these conditions, to speak of "resistance to change" by teachers is to miss the point. Teachers simply did not understand what was expected of them and understood even less what was expected of them in relation to computers. According to the Report on the Stanford/UNESCO Symposium[3]:

> *Few countries seem to have taken the necessary steps to prepare teachers to use computers, even when hardware is installed in schools. There is also little agreement on how to prepare teachers beyond short-term courses that merely help understand how to use computers in the classroom. The problems of implementing even this type of training are apparently great.*

It was in these conditions that diverse projects were begun in the early 1970s such as the French project entitled *"Expérience des 58 lycées"*[4] and the English project NDPCAL[5] (National Development Program for Computer Assisted Learning) which were the first experiments in Europe in the widespread use of computers in education.

The situation today

The arrival of the micro-computer towards the end of the 1970s revived political

action in favour of computers in education and this time it was in their millions or tens of millions that micro-computers were installed in schools and universities, to the point that the student/computer ratio in the most advanced countries is today of the order of one computer for 30 students and there are now few schools which do not have at least one computer.

In addition, efforts, sometimes quite considerable, were made in the area of teacher training but despite their amplitude, they were still insufficient both in terms of quantity (it is recognised that even in the most advanced countries scarcely 25 per cent of teachers have received a minimum of training) but above all in terms of quality as this training was most often limited to the computer manual and the basic software and included almost no indication of the pedagogical problems associated with using computers.

This massive introduction of computers and the lack of preparation of teachers led experts to make a certain number of not very optimistic statements:

- The Carnegie report entitled "The Fourth Revolution"[6] indicates that, by comparison with what was originally supposed, NIT in education has been introduced more slowly than foreseen; has cost more than planned; and has been added to existing equipment rather than replacing it.

- The Office for Technological Assessment (OTA) found for its part that "teachers who have taught with computers agree that — at least initially — most uses of computers make teaching more challenging... While computers can minimize some administrative chores and ease classroom discipline problems, the net effect is increased demand on teachers' time and creativity."[7]

- Moreover: "Faculty members who are interested in designing learning material for the new instructional technology usually are not properly rewarded for their efforts."[6]

- And to conclude: "While many software titles receive favorable ratings from review agencies and professional computing magazines, there is a general consensus among educators (and software publishers as well) that the quality of educational software could be much better."[7]

These considerations, in addition to others such as the difficulty of access to computer rooms, the lack of resources to buy software and the decrease in student interest in computers, help explain why a growing number of teachers has progressively shown a certain disappointment with NIT. Moreover, parents are aware of the problems being faced by the computer industry and employment prospects in this area are no longer what they used to be, even though the use of computers in businesses has become much more pervasive. Social pressure which largely contributed to the introduction of computers in education has diminished considerably and is not encouraging governments to undertake substantive action in this area.

Perspectives for the future

Each of the above factors, on its own, presents a problem. Taken together they form a serious obstacle.

The shortage of computers has forced those responsible to consider the optimisation of their use as well as their protection. This in turn has led to the creation of "computer rooms" with locked doors, where the students only go with their teacher during the times reserved for this activity in their schedule. Of course this allows the

best use to be made of the few computers available, but it also leads to the sort of use associated with the "Computer Centres" of 30 years ago.

It is perhaps worthwhile to remember that PC stands for Personal Computer — and a student who goes to the computer room when told to do so by his teacher, and who uses a program chosen by his teacher, hardly gets the impression that the computer he is using is a personal computer working for him.

Similarly, the teacher who has been given use of the room for one hour looks to make the best of the allotted time and is likely to choose a program which will occupy the students for the entire hour. This is admirable in itself but has the effect of reversing the usual practice which consists of occupying the computer as much as possible in order to free the user from the corresponding tasks.

This state of affairs naturally leads software designers, who know that teachers are the ones who decide which programs are bought, to write programs which occupy students for an hour and which do not stray too far from the usual pedagogic practice of teachers. Accordingly, "The potential result is a relatively homogenous set of products that fall far short of the possibilities provided by the new learning tools."[7]

And that is how with even the best intentions, we end up, as the French say, *"utilisant les nouvelles casseroles pour faire cuire la vieille soupe"* (using new tools but keeping the old methods). It is therefore no surprise that practically nothing has changed in education in the last thirty years despite the presence of thousands of computers, and it is likewise not very surprising that teachers have become disappointed.

One might add that simply doubling or tripling the number of computers in schools (which would represent a considerable investment) would not change current practice much and therefore would not alter the present situation. One might also add that connecting computers amongst themselves or to a local, regional or international network by fibre optics or by satellite would not change things much either.

The problem lies elsewhere. It lies in the practicer induced by the shortage of computers. These practices, which work against new and efficient uses of computers, will not change until the shortage problem has been resolved, i.e. once each student and each teacher has his own portable computer. This is the necessary condition, even if on its own it is not sufficient, for change in practice to come about, if the computer is really to become a personal tool for the student to use to do what he wants, however he likes and whenever he feels the need during his work.

If one believes the statements made by various manufacturers, this day is not very far off and the pressure that the students will then exert on both teachers and the education system through the intensive use of computers and sophisticated programs during classes might very well lead rapidly to the reappraisal of both our practices and our education systems.

It is all the more urgent to consider this new and unexplored problem, since: "No conceptual framework exists to evaluate the relevance of results obtained in a computer-saturated environment compared to those obtained in computer-scarce ones."[3]

Let us hope that this will not lead to a repetition of what some have called in the past "the calculator syndrome"[8] which, when calculators first came out, led certain teachers to make desperate efforts to invent questions and problems which could not be answered with a calculator.

iii) The task of educational building designers

(by Sam Cassels)

The designers of educational buildings have a unique responsibility because they give physical expression to the meaning of education in a society. What education represents for all of us is now changing faster than ever before. We are all therefore concerned about the best way of providing flexibility in the systems we create.

Yet much about the way we use buildings remains the same. What changes most rapidly is the range and diversity of ways in which people exploit space for new and unpredicted uses. What changes most slowly is the cultural significance we give to the role of education and to the monuments we build in its service. The language of design should reflect and enrich the evolving language of education. To walk into an educational building, even one which is empty, should be an experience which in itself increases understanding and enthusiasm about learning.

The Past

The history of educational buildings is a complex one. However I would propose a sequence of catalysts, drawn from UK experience, which have provided the agendas for past and present designers:

- Social Privilege, where buildings, in their form and content, reflected the classicism at the heart of their teachings to an exclusive elite;
- Social Engineering, which used buildings to demonstrate a commitment to purposefully improve the lot of the population;
- Functionalism, where the design of buildings flowed from a supposedly objective analysis of the functions that took place and the resources needed;
- Ergonomics, which concentrated design effort on providing the typical individual with an optimum physical environment;
- Information Technology, which seemed to revolutionise the way we thought about the teaching process and demanded buildings which first and foremost served the needs of the computer;
- Social Responsibility, where increasing awareness about the environment and its impact on both the planet and the individual altered forever the criteria we use to assess a "good design".

Life was never so simple as the above list would suggest. But a constant theme throughout has been the gradual erosion of the idea of educational buildings as primarily "landmarks for learning". The challenge of the 21st century will be to recapture the means of expressing the significance of learning in the buildings we design, whilst absorbing the increasingly sophisticated pressures from social and technological change.

The Future

On their first day of attending MBA courses in the USA, students at prestigious business schools are given a portable, laptop computer. In most schools internationally they will then be taught in teams through the medium of case studies designed to expose them to the demands of business life. These students have competed for these courses and their commitment in both time and money is significant. The learning spaces required by them are not driven by technological demands but by the need to create an environment which will attract students, provide them with a place to meet their peers and teachers, and a common

physical access to the key resources they will need to complete their courses.

Many readers may be more concerned with providing learning spaces for more comprehensive educational systems within which the above example is but a tiny part. However I think that it highlights some key points about the learning space of tomorrow.

- Technology will become increasingly dispersed and potentially anarchic. Predicting the future of technology is something even the designers of that technology are not prepared to do. Buildings designed to support a single view of the future will be almost immediately obsolete.
- Access to ever newer technology will be the key factor in acquiring knowledge. The provision of larger and more comprehensive centres for resources and communications will be the only way to provide general access to learning opportunities.
- Classrooms are not the places where the majority of learning will take place. Classroom spaces will no longer dominate the educational built form. Instead the provision of better support spaces, such as library and dining, and spaces for shared events, such as drama and sport, will become the priorities.
- Buildings will no longer merely support learning but rather inspire learning. The building will attract the student because it is simply an enjoyable place to be.

For many students of all ages, either because of compulsion or economic circumstances, many educational buildings are "prisons of learning". New technology has empowered the individual. Many will choose to use this power to "escape" from the need to use educational buildings. To remain relevant to the needs of the future the learning spaces of tomorrow must provide a welcome harbour for those students, and must regain meaning in the community by being recognisable as "landmarks for learning".

Notes and references

1. B.F. Skinner, *The Technology of Teaching*, Appleton-Century-Crofts, 1968.
2. A. Pantages, "Control Data's education offering", *Electronics*, May 1976.
3. *Computers and education: which role for international research*, Report of the Stanford/UNESCO Symposium, Stanford University, March 1986.
4. J. Hebenstreit, "Informatique et enseignement", Comptes rendus de l'Académie des Sciences — *La vie des sciences*, tome 1, No. 5, octobre 1984.
5. *Two Years On*, Report of the Director, Council for Educational Technology, NDPCAL, 1975.
6. *The Fourth Revolution*, Report by the Carnegie Commission on higher education, MacGraw Hill, 1972.
7. *Power on: New tools for teaching and learning*, US Congress, Office of Technological Assessment, OTA-SET-379, Washington DC, September 1988.
8. J. Hebenstreit, *Computers in education: Things to come*, Proc. 8th International Conference on Technology in Education, Brussels, 1989.

II. THE BASELINE

This section summarises the written contributions made to the Rochefort seminar and provides the context for the ensuing chapters. A number of countries commented on the position reached by their education system in the implementation of the use of new technologies and of the effect it was having on the provision of educational buildings. The style and content of these papers varied considerably, ranging from those that gave a résumé of recent developments at national level and an indication of national policies for the immediate future, to those which dealt with the provision for a particular district, or even a particular school. The coverage provided by the papers is, therefore, far from comprehensive — not all countries taking part in the seminar provided information, and for those that did, no common structure of reporting was imposed. Together, however, the documents provide an overview of the situation in 1991 — the baseline from which discussion developed.

Readers who wish to follow up any particular country's information are referred to the list of papers at the end of this section. One paper was quite different in kind from all the others: that by Duckenfield and Stirner was a specially commissioned document (not a national one) covering the subject of continuing education and training, in order to give seminar participants information from outside the field of formal schooling. Their paper is summarised separately at the end of this section.

i) Technology

Microcomputers

All the countries provided information about the provision of, and present use of, microcomputers in their schools. Wide variations in the scale of provision were reported.

At one end of the spectrum were Turkey and Greece where provision of microcomputers was really only just beginning (although Turkey has a national programme to supply 6 500 microcomputers in the 1991 financial year), and then only to selected types of secondary schools. Spain was further forward than this through its national ATENEA project.[1]

At the other end of the continuum were the USA and UK where almost all primary and secondary schools are equipped (the ratio of pupils to microcomputers in English secondary schools now being 18:1 — with the specialist City Technical Colleges working to a target of 3:1). All countries are making efforts to see that microcomputers become a standard tool in schools both for teaching purposes and also for administration.

The major provision of these microcomputers is in special "computer rooms", both in order to provide access to them for the maximum number of students in class or part-class sets, but also in order to ease the problem of security. However there are growing indications from Australia, USA (New Orleans), France, Holland, Scotland and England that microcomputers are being used in some circumstances as learning tools by individual students in a variety of non-traditional classroom situations.

Satellite television

The USA has been using satellite television systems for educational purposes for some time. New Orleans schools, along

with others in Louisiana, are currently sharing live, interactive classes with students in other American states through the "Star Schools" project, which is designed to offer sophisticated, college-preparatory courses to schools which do not have the teachers, or sufficient numbers of students, to justify a special class.

France, too, has a national programme for the provision of learning at a distance through a variety of new technologies, including satellite. Seminar participants visited the *Centre National d'Enseignement à Distance* (CNED) in the Futuroscope Park at Jaunay-Clan near Poitiers and saw the facilities for production of programmes for distribution via the Eutelsat satellite; some participants subsequently were present at the reception of one of these programmes at the Jean Rostand school at Montpon-Ménestérol in the Bordeaux Region. Again this is an interactive system, allowing audio and video feedback between the receiving school and the CNED centre. An interesting use of information from a remote-sensing satellite (for which special receiving equipment is needed) is being made by the *Lycée Pilote Innovant* at Jaunay-Clan in teaching geography.

The huge distances in Australia have led various states to make use of broadcast and satellite television for educational purposes for several years. There is now a proposal for a nation-wide network for educational purposes making use of the Aussat satellite.

Several countries, now including Turkey, are making use of ordinary television broadcasting for educational purposes.

Cable/telecommunications

France has a national policy related to the use of cable in education. The overall purpose is to see cable television and telecommunications links as an "interactive multi-media resource". The implementation of this policy is in the hands of the various *Rectorats* (regional offices of the Ministry of Education), and participants were able to see the installation at Le Haillan in the Bordeaux region, where the educational use of the cable system is seen as a forerunner of the cabling of the whole commune. Information was also provided about several cable-related projects and members saw the results of the total cabling of the *Lycée Pilote* in Jaunay-Clan. France also has the advantage of a nationally available videotex system, Minitel, which is being used quite widely for a variety of educational purposes.

The New Orleans schools (USA) report an interesting use of their local cable television network. An agreement has been made for students to provide a homework-assistance programme to fellow students. This and other cable TV-based projects demonstrate a community use of the cable network which has interesting implications for other countries.

Both Australia and Scotland are making use of their telecommunications networks for the provision of specialist teaching to small schools in remote areas, which might otherwise have to close. In each case the system depends on a teacher at one school using an electronic white-board, computer-generated data and graphics and sound to provide teaching over a fully interactive (audio and graphics) link with students in the distant schools: the students use small writing tablets for graphic interaction as well as microphones for normal speech contact.

In Norway, too, the same problem of maintaining a full curriculum at small secondary schools in sparsely populated areas is being overcome by the use of telecommunications links and microcomputers,

allowing teachers to teach in more than one school at the same time.

In Spain, as part of the ATENEA programme, an educational electronic mail service is being established through which teachers can obtain information about computer programs and videos, training courses, and details of other teachers' experience in using new technologies.

Of particular interest is the use of cable networks being made in the town of Tilburg in Holland. In a project funded jointly by the municipal council and the Ministry of Transport and Public Works, the teaching of some students at the Rooi-Pannen school will take place in the students' homes.

Each student will have a computer connected through the public telephone system to the "practical centre for automation and telematica" at the college from which their lessons will be provided. The experiment began in October 1991 and will be evaluated after a year. The intention underlying the experiment is to reduce the number of students using cars and public transport when travelling to the school, in order to solve traffic problems in the town as well as helping overcome environmental pollution problems. It aims to deal with an environmental, not an educational, problem.

Other technologies

Both Scotland and France make specific reference to the use of interactive video systems: in Scotland for staff development purposes as well as for teaching in schools; in France as part of the experimental use of new technologies in the *Lycée Pilote* at Jaunay-Clan. The use of CD-ROM in libraries and to provide reference material for distance education is also mentioned in the information from France.

ii) Society

Some of the societal pressures which are leading to demands for the use of new technology come out in the papers submitted for the seminar.

In Holland there is the Tilburg experiment, already referred to, which springs from environmental pressure. But the paper also refers to the problem of competition between educational institutions which will arise when European frontiers are opened in 1993, when it will become possible for Dutch students to choose to go to nearby German colleges (for example) and vice versa. This is expected to lead to changes in the "image", in terms of architecture and fittings, sought by schools and colleges in order to be more attractive to students of various ages, as well as to changes in the teaching and learning methods used in order to be both up-to-date and efficient.

The importance of retaining adequate school provision in remote or sparsely populated areas has already been referred to in the section on technologies, but it is a politically important issue in several countries, especially Australia, Norway and Scotland, and also in some of the remoter regions of France.

The way in which schools are already becoming more integrated within their communities is shown by their interaction in New Orleans in the USA, where commercial cable network owners are prepared to co-operate with schools and community leaders in providing facilities for specialist services, including the transmission of television material made by students.

The project in the commune of Le Haillan in Bordeaux shows how both educational authorities and local politicians can work together to provide a facility

which will enable the benefits of new technologies to be available not only to schools and colleges but also to individual homes in the community.

iii) Education

The image of educational activity which comes from the submitted papers is one of the predominance of structured, formal, classroom teaching in most of the countries concerned. Indeed, even in England where individualised teaching is probably more frequently practised than in other countries, an Inspector's report on a major innovative project criticised the "tendency for teaching styles to remain mainly didactic, with a reluctance to adapt to styles of teaching/learning that fully exploit the technology available". In Spain's ATENEA project, great stress is being placed on the need for teacher training in the use of the new technologies in order "to inculcate a spirit of innovation". And in the educational institutions in France visited by seminar participants, with the sole exception of the *Lycée Pilote*, the new technologies were being employed in support of what appeared to be formally structured, class teaching.

There were, nevertheless, important signs of change. The information from Holland referred to the tendency for teachers to be working directly with larger groups of pupils for didactic input and for this to be supported by individual work by the students using the new technologies. Reference has already been made to the use of cable television in New Orleans permitting students to give homework assistance to other students. Also in that city, the computer rooms in schools are being used to provide courses in computer skills and literacy for the parents and grandparents of students — bringing all ages of the community into the school premises.

Perhaps the clearest statement of the new philosophy of teaching and learning related to the use of new technologies is given in the information about the new Aisakello primary school being planned at Kontula, Helsinki in Finland. The following targets are given for the use of the new technologies at the school:

- to give information about different communications systems and their impact;
- to develop the ability to understand the "language" and the style of expression of different communication systems;
- to teach the child to express himself or herself through the different means of communication;
- to offer a way of working which is rich in experience;
- to develop a readiness to seek and select independently the required message from an abundant supply of information;
- to develop a creative and scientific approach to thinking.

This educational approach is to be reflected in the structure of the building, which is referred to below.

The decision to use the new technologies as the means for retaining fully operational schools in remote or sparsely populated areas is important as a reflection of an educational trend, as well as being a matter of technological interest. Governments and local authorities are recognising that communities value the contribution made by a centre of learning in their town or village and welcome its retention with a full curriculum and range of facilities, even when

achieving this by the use of new technologies is a slightly more expensive option than closure.

The contribution which the new technologies can make to the education of students with learning difficulties is part of the Spanish ATENEA programme, as it is also in the work in the New Orleans schools. Both also refer to innovative use of computers in the teaching of art and design.

iv) Buildings

Several examples were given of providing for NIT in both new and existing facilities. The Aisakello primary school in Kontula, Finland and the new Leith Academy in Scotland clearly express a philosophy of education based on the use, and understanding of the impact, of new technologies.

The Aisakello primary school is at the planning stage and is to be completed by summer 1994. It is being planned as a unit integrated with a day-care centre and a play school. Although the architectural image of the school is not yet defined, its structure will "try to forget the old 'teacher-before-a-class' concept; the classrooms will be a place where the pupils themselves take responsibility for their own learning... The classrooms can be joined by movable walls and there will be several small rooms for separate team work." The school will be provided with data transmission networks, personal computers, TV receivers and video systems, as part of the school's declared teaching philosophy of "applying all the new communications methods that modern technology provides for educational work".

Leith Academy is now open as a 900-pupil secondary school. It "is planned like a shopping centre, with a glazed main street..." and a structure deliberately designed to "allow changes of function to be managed without ripping the building apart". The structure is also designed so that "future sub-leasing of coherent blocks of accommodation can take place, and the waste of half-empty schools avoided".

The *Lycée Pilote Innovant* at Jaunay-Clan not only makes use of new technologies in teaching, but also presents a deliberately "high-tech" architectural image. The building has been in use for four years and the report provided by the principal of the *Lycée*, identifies not only the successes and the failures, but also those matters which still need further time for adequate evaluation.

The reports from the United States, Norway, Turkey, Greece and Scotland all refer to the problems experienced in fitting the facilities for new technologies into old buildings. Norway comments on heating and ventilating problems and solutions springing from their cold climate — while Turkey and Greece have the same, but opposite, problem with their hot climates.

The English report, based on several years' experience of the use of new technologies and teaching methods, highlights the need for an increase in the teaching/learning areas in school buildings of between 15-20 per cent in order to accommodate the extra movement of students and the use of small-group working.

Most of the reports make some reference to the need to provide special security measures in school buildings making use of computers and related equipment, ranging from "special locks, steel doors and infra-red movement indicators" in the German report, to "a comprehensive intruder alarm system including closed-circuit television, video-recording cameras" in Scotland's Leith Academy.

v) Technology-based learning in continuing education and training (A summary of the paper by M. Duckenfield and P. Stirner)

Unlike in schools, where it usually offers an alternative means of providing an "existing" service, the application of new technologies in continuing education and training (CET) often involves the creation of entirely new "markets" and "customers" for learning — ones which could not easily or cost-effectively be catered for otherwise.

Higher education regards the use of technology-based learning both as a means of increasing student participation rates in undergraduate programmes without substantial extra cost, and also of expanding revenue-producing CET provision to industry, commerce and the professions. Both are possible through the development of short course modules which can be assembled into distance learning packages, made available by satellite broadcasts or recorded on videotape and used in the classroom.

Companies, faced with the need to raise skills and expertise in their (rapidly changing) workforce in order to remain competitive, see technology-based training as a natural by-product of the same technological innovation that is a key factor in creating the need for CET. "If technology is causing the problem, why not use it to create solutions?"

Training solutions will have to be found that are relatively cheap — where most of the costs go into providing the training itself, rather than into paying overheads and expenses, such as travel and subsistence. They must also provide flexibility of delivery to minimise production costs. They must be accessible — as easily available in small towns and small firms as they are in urban centres and major corporations. And they must be effective in terms of learning. This will only be achievable through the widespread use of new technology.

Current examples of such uses of technology-based training are:

- IBM's Education Television Network, developed by the company to improve access to training and to lower costs, especially in travel to and accommodation at central training locations. The network enables an instructor in a central studio simultaneously to teach students in remote classrooms (currently in six cities throughout the UK). The system uses video-conferencing facilities which allow a two-way flow of information between instructor and students. Communication is by leased lines which carry both compressed video and audio information, and also data traffic between the controlling IBM PS/2 computer workstations.

- British Telecom's use of interactive video was introduced to overcome the problem of communicating the company's changes in staff appraisal procedures to over 30 000 managers. An appraisal and counselling training package, comprising a video disc in two parts and a follow-up workshop was produced. Each part of the video disc consisted of eight modules which trainees could study in any order they chose. They could review or omit any of the modules, freeze action sequences, and check their progress through an interactive sequence on completion of any module. Some problems were found in siting the equipment in suitable environments, but most managers felt the method held their attention and they liked learning in this way.

- The Association for Media-based Continuing Education for Engineers (AMCEE) is a consortium of 37 leading

technological higher education institutions in the United States set up to support continuing education for engineers in member universities and to improve access by engineers working in industry to the latest technical knowledge. It does this by selling, and broadcasting through the National Technological University's satellite TV broadcasts, over 500 courses in 16 engineering disciplines. The courses are available as recorded videotapes as well as live broadcasts by the National Technological Univeristy. Courses are supported by lecture notes and a system of "learning managers" — local experts in the particular discipline who can lead discussions, manage the learning environment and liaise with the academic on the tape who actually provides the instruction. This material is available right across the USA.

- The European Programme of Advanced Continuing Education (EuroPACE) aims "to help European industry in its urgent need to stay competitive, by providing the most up-to-date knowledge... using advanced information and communication technologies". It is a collaboration between the European Community, higher education and several leading telecommunications and computer companies, intended to provide a distribution system for transmitting advanced training courses and seminars by satellite to company managers and professionals as well as to staff and students in higher education. The seminars, devoted to leading edge technologies, typically consist of two- to five-hour transmissions combining presentations by experts, with video film and charts as illustrations, followed by discussion involving an audience at the initiating institution and all the remote audience, who are connected by satellite, telephone, fax and electronic mail.

The original paper by Duckenfield and Stirner gives much more information about each of the examples summarised above.

vi) Seminar papers referred to in this summary

England: Some personal observations on the impact that new technologies have had on educational building in England. (A. C. Thompson)

Finland: Aisakello School in Kontula, Helsinki. (R. Tapaninen)

France: CNED videotransmission, Press Review — Poitiers.

The Microcomputer as a teaching aid for developing the pupil's autonomy. (F. Samson)

Le câblage dans un établissement scolaire. (Réseaux Câblés d'Aquitaine)

Germany: Personal commentary. (M. Scholz)

Greece: New technology and its impact on educational buildings.

Holland: Information technologies and the consequences for school buildings. (S. Arbeek)

Norway: New technology and its impact on educational buildings. (R. Engeness and O. Stautland)

PEB: Technology-based learning in continuing education and training. (M. Duckenfield and P. Stirner)

Scotland: New technology and its impact on Scottish educational buildings. (I. Herd)

	New Leith Academy. (Lothian Regional Council, Department of Architectural Services)
Spain:	The Spanish ATENEA project.
Turkey:	New technology and its impact on educational buildings in Turkey. (G. Agis and F. Leblebicioglu)
USA:	A New Orleans case study. (K. Ducote and B. Hatfield)

Notes and references

1. *Proyecto ATENEA: Evaluators' Report*, Ministerio de Educación y Ciencia/ CERI/OECD, 1991.

III. TRENDS

In order that readers may more readily assess the extent to which they agree or disagree with the predictions made about the next two decades, this section of the report is subdivided. In reality, however, all the trends — technological, societal, environmental and educational — are interdependent. Changes in one area will have repercussions in others.

It is significant that, as will have been seen from the information gathered for the Baseline section of this report, the speed with which these trends will appear in practice will vary greatly from country to country. Some, especially in the technological section, are already at, or near to, implementation.

i) Technological trends

In order to handle the very wide range of developments in this field, technological developments are subdivided into those related to computers and computing (including mass storage, and multi-media systems); satellites; and telecommunications. These divisions are recognised as being arbitrary, because, again, they are all interrelated and because computers, in some form or other, are an element in all of them.

Computers and computing

The computer market, with a current installed base of around 25 million personal computer systems, is estimated to be growing at a rate of 50 000 units per day worldwide. This growth rate is expected by trade sources to continue "at least for the next decade". The ratio of performance to cost has been increasing at a rate of some 20% per annum over the past twenty years: it is expected to continue to do so. The implication of this growth in the market allied to decreasing cost in real terms, is that we can expect many school children (at least in the most developed countries) to have their own PCs, with something approaching the power and facilities of today's desk-top business machines, by 2005.

Computer developments will continue at a pace similar to — or even greater than — that of recent years. They are likely to lead to:

- equipment which takes up less space, much of it designed to be truly portable (developments in battery technology are related to this);
- a substantial move towards flat-screen displays, which will eventually overtake VDUs based on cathode-ray tubes, with consequent savings in power consumption, heat generation, and space;
- the ability to present and manipulate three-dimensional images on screen (though this will probably remain an expensive and highly memory-consuming facility);
- improvement of speech recognition techniques so that speech input of commands and data becomes possible, thus reducing, or possibly eliminating, the need for keyboard skills (depending on success in developing both neural networks and artificial intelligence software);
- major improvements in the computer's ability to handle text: for example handling relational connections in full-text documents (through artificial

intelligence techniques), or reproducing speech direct from text (using neural networks);

- the ability to receive data from short-distance radio transmissions will permit "unwired" network connections;

- improvements in "user-friendliness", for example the use of stylus and digitiser for control and low-volume data entry (like using a pen to point and write), speech input of commands and probably of text, and even greater use of icons in software;

- standardised software interfaces which will make it possible for different types of computers to exchange data over communications links.

Mass-storage developments will underpin all of the computer developments referred to above, because they will provide the large increase in memory required to provide the more complex facilities. Optical disc technology will continue to develop from the present "publisher-manufactured" CD-ROM disc, through "write once read many" (WORM) discs which can be produced by the user, but not altered once made, to mass-storage optical discs which can be recorded and erased (though these may not be reliable until near the end of the period covered by this report). It is reasonable to predict that storage capacity for data will not be a limiting factor on computer developments over the period under review.

An important spin-off from optical disc technology is the development of optical memory cards. These credit-card sized devices can already hold 2Mb of memory. Their potential value in educational and training uses seems likely to be considerable, especially if commercial use of these memory cards and other types of "smart-cards" (which are already in use for financial transactions, for medical data, in portable and stand-alone terminals, in point-of-sale systems, and as removable memory in laptop and pocket personal computers) expands as currently expected.

Interactive multi-media systems will continue their development from their optical-disc base. They will provide a new and powerful medium of communication through their ability to combine electronic text and high-level graphics with audio and full-motion video.

Whether the major market will go to the CD-I[nteractive] "stand-alone player" development or to the DVI (Digital Video Interactive) which integrates existing PCs with CD-ROM storage, remains to be seen; as indeed does the possibility of developing an expert system to overcome their incompatibility. But in either case, a truly new and potentially very powerful medium of communication will exist.

Satellites and broadcasting

The use of satellites for the distribution of television and other material across much of the earth's surface will be commonplace. Although at present these facilities are most frequently used for commercial or entertainment purposes [it has been estimated that 9.5 million homes in Western Europe will be receiving satellite television (DBS) by the mid-1990s], education has already proved its ability to make good use of them, providing the costs are within its reach. Subject to that proviso, satellites will be used to:

- deliver television signals, including high-definition television, across national boundaries with sound commentaries in several languages (the problem caused by differing national television standards may remain);

- provide teaching and training programmes addressed to individual receiving sites, as well as for general reception;
- deliver a mixture of sound, text, data, graphics and full-motion video, probably with the capability of interaction from receiving sites using some or all of these media.

Satellites will enable, for example, the use of video-conferencing facilities over considerable distances (including internationally) as part of courses; the delivery of university-level courses to distant or isolated sites and to other nations; the co-operation of groups of schools from more than one country in the preparation and distribution of programmes and other materials in a variety of languages; and students to work on environmentally sensitive issues using live data about the earth and its atmosphere.

At a simpler level, they will permit the reception by educational institutions of general television broadcasts from a wide range of foreign countries. In this context, it can be expected that there will be widespread availability of personal television receivers (as with today's "Walkman"-type radio and cassette players), many of which will be owned by students themselves.

Ordinary broadcast radio and television will continue to contribute educational programmes (although this will be increasingly dependent on national and commercial policy decisions about competing media and the tension between social and commercial pressures). Facilities such as the "night hours" transmission of data, and the transmission of data and switching signals simultaneously with daytime broadcasts will also be available for use by education services.

Telecommunications

This is a technology which is developing rapidly. However, the speed of application of the new developments and the choice of which to use, are more dependent than any of the preceding technologies, on national policies, availability of funds for investment, and (in some cases) the terrain of the country. This makes prediction of the date by which particular technologies will become available very difficult, because it will vary from country to country. We can expect however that the telecommunications industry will be moving towards the following position by 2005-2010:

- Provision of integrated services digital networks (ISDN), which will end the division between voice (analogue) and data (digital) communications. ISDN will permit the simultaneous transmission of voice and data and give access via a variety of electronic devices to a wide range of services. In practice, this will mean, for example, that a user will be able to interrogate a database while talking to a client on the telephone and simultaneously editing the text which appears on the screen — all on a single ISDN line.
- The development of integrated broadband communications (IBC) which would permit the interworking of voice telephony, data packet transmission, ISDN, broadband video (interactive and distributive), satellite transmissions, and mobile (radio) telecommunications.
- Provision, either within another network (ISDN or IBC) or separately, of very high speed data links, with transmission speeds in the Gigabit/second range.
- Expansion and development of the mobile (cordless and cellular) telephone network, providing a small hand-held unit capable of transmitting data, fax, and low-rate video, as well as voice. This will operate within buildings (with

interconnection through wireless PBXs) as well as out of doors, and will have a full interface with ISDN networks.

These facilities will permit:

- a considerable growth in the use of facsimile (fax) for document transmission: personal computers will have integrated fax reception and transmission capability;
- integrated networks for electronic mail and for videotex systems (overcoming current incompatibilities).

The use of optical fibre to provide broadband transmission facilities will occur both within national telecommunications systems, and in separate cable systems designed primarily for the distribution of television to homes or to community facilities. Commercial broadband cable facilities will be able to provide the same data, voice and video transmission as the telecommunications system, but national regulations may not permit this.

ii) Societal/political trends

The trends set out in this section are both derivative and selective: derivative in that they are based on a personal reading of other people's reports and predictions, and selective because they include only those trends which I think will have some impact on the main thrust of this report — the demand for and use of educational buildings.

Economic/industrial

The developed nations will move more and more towards a post-industrial "information-based" economy which will lead to:

- Human capital becoming the key requirement of economic development: it has been suggested that by 2010 seventy per cent of all jobs will be "cerebral" with half of them requiring people with a university degree or professional qualification, and thus requiring a considerable expansion of higher education provision.
- Learning being the main work in three quarters of all jobs — either people needing to absorb and act upon new information, or people helping machines to learn.
- The functional requirements of half of existing jobs changing completely in five years, creating a permanent training need.
- Increasing transience of workers in any particular organisation: it has been suggested that at any one time 36 per cent of workers in the United States will be changing or expecting to change their jobs — again resulting in an increased need for training.
- Women forming 45 per cent of the workforce, with the resultant provision of child-care facilities at the workplace.
- A considerable increase in the number of "teleworkers": people who work from home, using telecommunications links to relatively remote offices. It has been suggested, for example, that 50 per cent of the London workforce will spend some part of the week working from home in this manner; it is city workers who will be most affected. The United States already has over 10 million self-employed teleworkers.
- The phenomenon of unemployment existing alongside job vacancies as the mismatch between workforce qualifications and level of training and the requirements of the new jobs continues to grow.

The move into a post-industrial, knowledge-based society will have an impact on a wide range of social activity.

- There will be increasing decentralisation of government and business activity. Telecommunications networks will mean that a person seeking information or service may well have that need met by someone hundreds of miles distant. All members of society, including children, will therefore become used to the idea of seeking information from a remote source over the telecommunications network.

- The use of powerful telecommunications facilities by governments and large businesses will put local, charitable, educational and public service activities at a disadvantage unless they can find the funds necessary to provide — or obtain access to — equally powerful networks.

- The widespread public availability of information from a variety of different sources, including sources outside the country, will cause increasing awareness of societal differences and will lead to increasing diversity in the social order itself. The problem of "overchoice" available to people who have no experience in handling it, will be a concern.

- The availability of broadband networks will lead to increasing changes in shopping practices, strengthening moves to out-of-town shopping centres (dependent on computerised stock control and "just-in-time" delivery of goods) and also to "teleshopping" — purchasing from electronic catalogues. This could lead to towns losing their shopping "heart", and to decisions to replace this with a cultural, leisure, and educational "heart".

- The potential isolation of individuals in their homes will be recognised by increased pressure to use leisure, shopping, cultural and educational activities as occasions for socialisation.

Environmental

National and international policies intended to protect or to improve the environment will have an impact on many aspects of daily life, not least because they are likely to be expensive and therefore to take a larger proportion of government funds. The most important effects from the point of view of this report are likely to be:

- restrictions of various kinds on the use of cars as private transport, both in order to reduce the emissions from exhausts and to reduce the clogging of towns and cities;

- pressure to reduce the level of commuting, by taking as much work as possible to people, rather than people to work;

- policies to reduce the consumption of power through the use of more effective thermal insulation of buildings; more efficient sources of lighting; materials for the construction of buildings, furniture and other goods derived from renewable or recycled sources;

- greater use of computerised control systems within buildings of all kinds to improve the efficiency of use of resources.

National identity

Satellite broadcasting and powerful telecommunications networks will not be constrained by national boundaries. It will be difficult — if not impossible — for a nation to isolate itself from the impact of

other nations' cultures. Not only will the output of other (perhaps competitive) nations' broadcasting, educational and commercial concerns be receivable by anyone owning appropriate equipment, but it will also be open to individual citizens to obtain information direct from (for example) official statistical sources in other countries to compare with that provided locally.

There are likely to be two results from this. On one hand, there will be the possibility of attempts at cultural domination by nations prepared to invest heavily in their media industries and their technological facilities for communications. On the other hand, the very fact of what will be seen as "cultural pollution" will lead to the use of the same channels of communication to strengthen the identities of smaller and smaller cultural groups. The technology will permit diversity and individual choice within the context of a growing international information flow.

iii) Trends in education and training

The difficulty in establishing trends in education and training systems is that they vary so much from country to country, even within those concerned with PEB. The weight of history and cultural traditions lies heavily upon our educational provision — perhaps more than on any other aspect of national life. Any overview will inevitably describe trends which some readers will consider not to apply to their country or their system. Nonetheless, under the impact of the new technologies national and cultural boundaries are blurring. What is happening to some today, may well happen to others tomorrow.

Training is considered alongside education, not only because the boundary between those two elements is differently defined from country to country, but also because buildings currently described as "educational" will increasingly be used for what is currently called "training" — and vice versa. The distinction between the two terms is gradually losing significance.

Status and expectations

As the demands of an "information-based" society become more apparent, governments are moving the education and training of their peoples higher up their list of priorities. They will call for a higher return from their investment in education and training facilities, both in terms of "level of product" and in terms of value for money.

There will continue to be a tension between those who see education as primarily concerned with "developing the whole person", and those who see it as primarily concerned with fitting people to work and live in their future society. Which of these two views predominates will depend on each country's view of the balance between the personal and spiritual benefit to its people as individuals and the economic benefit to its society as a whole.

Whatever the outcome of the tension between those views, there will be considerable changes in the demands made on the education and training system, because:

- The currently widening gap between the pervasive use of new information technologies in the world of work and leisure and their very limited use in educational institutions must be closed. It has been suggested that present educational methods are actually harmful in that they inculcate skills and methods of working opposed to those required by an "information-based" economy (see also the section on teaching methods).

- The fundamental bases of education (all those things learned in the early years of schooling) will need to be grasped by children both more effectively and more quickly than at present, in order to underpin the more advanced and more individualised learning required as their education and training progresses.

- Pressure on national budgets will require education and training systems to be more cost-efficient. The use of sophisticated, computerised administrative networks will be commonplace, requiring inputs from teaching points as well as from the administrative office of the institution.

- The training/re-training cycle must be accelerated, with education and training becoming much more tailored to the specific needs of an individual, and increasingly provided on a "just-in-time" basis. This can be done through the use of the new technologies; the constraint on doing so will come from educators' lack of understanding of how to make the most effective use of the technology, rather than from any deficiency in the technologies themselves.

- Individual people, perhaps from ages as young as 12 to 13 years, will become increasingly responsible for the progress of their own development and training, negotiating and working according to "learning contracts" covering the content, duration and place of the various elements of their educational and training activity.

A word of warning may be necessary. Circumstantial evidence suggests that the new information technologies are not yet as much a part of the general culture of educators and politicians as they are in the culture of commercial and industrial leaders. Governments will increasingly be asking, over the next twenty years, for decisions and actions from the educational world which some of its leaders are ill-prepared to take. They themselves have a training need in this area.

Pressures of cost, staffing and demography

From what has gone before, it is obvious that as nations move towards an information-based economy, the cost of their education and training provision must rise. Equally it is obvious that strenuous efforts will be made by governments to keep this rise to a minimum.

In all education systems, the cost of teaching materials and equipment represents one of the smaller elements of overall budgets (around 10 per cent). If this element rises in order to cover the increased provision of computer and telecommunications-related equipment and their consequent day-to-day running costs, savings will be looked for from the major elements — premises (about 15-20 per cent) and teaching staff (about 50 per cent).

Individual governments will make different decisions about the balance of expenditure on various levels of education and training. In general, provision over the twenty-year timescale will probably favour further and higher education (those over 16 years of age) at the expense of those in the earlier years, and favour the training and re-training of adults at the expense of formal education.

The staffing structure of educational institutions will change in a variety of ways:

- Many countries will experience a shortage of qualified teachers, especially for children of the middle years (10-16). The reasons for this will vary between countries. In some, it will be caused by the drop in the societal status of the teaching profession and the consequent

low teacher recruitment in the 1980s; in others it will be caused by more attractive salaries and working conditions in the training departments of commercial, industrial and leisure concerns, or indeed within other aspects of those industries; and some countries will find that there is just not enough money to pay for all the teachers required.

- As educational systems make greater use of new technologies, they will need greater numbers of support staff. They will employ highly qualified information staff (currently librarians) who will have direct contact with learners, but whose skills will be quite different from those of subject teachers.

  There will also be managerial and administrative professionals with their own support staff. There will, especially, be technicians, to maintain the systems in optimum condition. These staff will be recruited and paid for at the expense of what are currently "teaching" posts, as the division between those who manage and those who facilitate learning becomes more marked as a result of the move towards more pupil-directed learning methods.

Many of the PEB countries will experience a drop in the number of children in school in the next ten years. Crude birth-rate statistics suggest that numbers will recover somewhat in the early years of the 21st century, but will not return to the levels of the 1970s. Demand for school places for those under the age of 16 therefore seems likely to be fairly stable at a little above current levels, but demand for places for those over 16 — the whole of the adult age-range — will increase considerably under the pressure for a more highly educated and trained workforce.

Teaching and learning methods and sites

It is worth remembering that even in a time of revolutionary change, many things remain much as they always were. There are still plenty of people who maintain that the introduction of new technologies will not suddenly reverse centuries-old educational practices. Others stress the process of alienation which takes place when students are confronted with technical artefacts instead of live human beings. My estimation is that the first of these views will be overturned by the demands of governments and peoples facing life in the 21st century, and that the second may well apply to the present generation, but will not apply to the one currently entering school.

Because this section seeks simply to establish trends, the educational reasoning behind the changes in teaching and learning methods identified is not explained. All are extrapolated from current practice and writing: the arguments about their educational validity and effectiveness are published. One can expect to observe the following:

- A steady move away from class-based teaching towards individual responsibility for learning.

  The move will be progressive as the students get older (and therefore more able to take responsibility for their own learning), that is, with more class-based teaching at first school level to very little at young adult level.

  This move will be driven by the need for those living and working in the 21st century to learn — in controlled circumstances — how to construct knowledge from information in the course of ordinary life, and will be facilitated by the availability of powerful, computerised learning-management packages. (We can expect "smart cards" to be carried by all older students not only as

means of identification when using computer-based learning systems, but also as a means of recording progress within past and current courses.)

The move will lead to much learning by older students taking place outside of school buildings, using open learning or supported self-study techniques; sometimes at home, sometimes in local "drop-in" learning centres to assist peer-group interaction; but always with electronic access to tutors and resources in their base "school".

- Much more learning which involves contact between students and teachers from other schools and colleges, often in other countries.

  The walls of educational institutions will become transparent (educationally speaking) as: students obtain information from remote sources; learning materials are received from other countries; project work is shared between schools, involving the exchange of and interaction with, materials including text, graphics, video and sound; and tutoring of individual students is sometimes carried out by subject experts from other institutions. The concept of "school" as a geographical entity will be eroded and may well disappear.

- The content of the school curriculum undergoing marked change because the fundamental thinking of current curricula will no longer match the skills needed for life in the 21st century.

  Today, learning and thinking is individual, sharing is considered to be cheating. But learning and thinking in the world of work is shared, and will be so increasingly as computerised management-information systems spread. Hand-written or printed text is fixed both in time and place, but electronic text is easily and immediately transferable and infinitely alterable, to ensure it is up to date.

  Memorisation still underlies much current teaching, but will it still be useful when information can be received on a personal computer-screen, which may be no bigger than a wrist-watch?

  Teachers, who are at present the major source of, or controllers of, the information needed for learning will find that they have become advisers on, and gatekeepers to a multitude of sources of information, many of which are outside their control. In much of their work they will be tutors, guides, counsellors, sources of judgement and experience, rather than providers. They will still be of vital importance, because they will be the people with whom ideas are discussed and tested, from whom encouragement and discipline are obtained, and above all who assess and aid progress. They will be the ones who teach the students to learn.

- The use of new technologies in the process of learning being pervasive.

  This has been prophesied before without it taking place. However, it may happen soon because of the widespread availability of cheap, powerful, portable microcomputers, often the property of students themselves. They will use them at home, not just for computer games and other leisure purposes, but also to obtain information, to book tickets for shows, and to buy goods. Their parents will do the same.

  This will match the world of work, where individual access to computer power "at the desk" is already commonplace and a far cry from the strictly programmed session in the "computer room" which is the current practice in schools. Indeed if schools do not make use of new technologies in this everyday

way, young people will become alienated from their educational provision because they will find it more and more irrelevant to their daily life.

There will be great changes in the place where learning happens. This does not mean the end of school buildings — apart from any other consideration, there are already thousands of them across the OECD countries whose useful lives will extend into the middle years of the 21st century.

We may however see a proliferation of places where learning takes place, many of which will not be what we currently call schools. Homes, factory and office training centres, company child-care centres, public libraries, town-centre culture and leisure facilities all will find themselves providing for learners of various ages, including the very youngest.

We may expect to find new life breathed into small schools. Holland College, Prince Edward Island, Canada, may provide a pointer:

> *The College is a multi-site institution with four major centres and supplementary centres spread over the Island... It thus has no campus as such, but uses a variety of houses, community buildings, redundant educational and industrial buildings for these centres. The buildings are seen as study centres where instructors conduct counselling services in suites which resemble 'live' work locations. Centres also act as a forum for student interaction and as resource centres.*[1]

Notes and references

1. OECD/PEB Long-term perspectives Nr. 4. *Individual learning*, Paris, 1987.

IV. FORECASTS

This section draws in part on the conclusions of PEB seminars held in Dunblane (1985), Segovia (1986) and Leicester (1989).[1] Although some of their conclusions will have been overtaken by technical progress within the timescale of this study, the reports remain useful documents.

i) What Buildings?

The above analysis of technological, societal and educational trends leads to the question whether the concept of a school as a single-use building occupied for only part of the day by an age-defined group of people will be acceptable in twenty years time.

It is not only that technological, demographic and economic pressures will militate against it, but its presentation of education as essentially separate from the rest of life will also, surely, become unacceptable in a learning-based society. So the first question to those responsible for educational buildings is simply "What buildings?"

It has to be recognised, of course, that countries already have a considerable school building stock which will last well into the next century. Much of this stock will however, simply be inappropriate for the learning methods and techniques which that century will require.

From now on, when a community is, for whatever reason, assessing the facilities it needs for the education of its young people, it should therefore consider completely afresh the type of accommodation that should be provided. This reconsideration should be as broadly based as possible, requiring the co-operative working not only of educationists and architects, but also of local community organisations, businessmen and families. Something of this nature is already happening, as projects like Golden Grove in Australia, Abraham Moss Centre in England and Leith Academy in Scotland — and many others — demonstrate. Nevertheless, even these have been thought of primarily as schools, although with far greater provision for community use than usual and far greater possibility of adaptation for other purposes than usual. But consider some of these ideas:

- If a major employer in a neighbourhood, as part of his attempt to encourage women into his workforce, is providing child-care facilities on his premises, why should he not be encouraged to co-operate with the educational authorities to provide learning facilities as well? Mothers could then take their children with them to a work-place school, saving an extra journey, and collect them at the end of the working day.

- If an employer is providing a purpose-built training centre for his staff (as many more will be doing to ensure they keep up-to-date) which is set up to provide "drop-in" open learning facilities, probably supported by the state-of-the-art production equipment used by his firm, might it not be possible for students at an appropriate level to use those same facilities — and the related equipment — for their own independent learning?

- If a local authority is considering ways of reviving the centre of a town which has lost its attraction to shoppers through the impact of out-of-town and electronic shopping facilities, might it not consider the provision of learning

and other cultural facilities for citizens of all ages as a way of keeping the town centre alive? This could be achieved by adapting spaces in town halls, libraries, post offices and other types of community buildings, as well as redundant shops, to provide — using the same technology that has deprived the town of its shopping interest — lively and attractive community learning centres. There are already proposals, for example in Scotland, for a college to open its own "drop-in learning shop" in a local High Street.

- Similarly, if a local authority is faced with a city clogged with traffic and suffering from the resultant pollution, and is seeking novel ways of reducing traffic congestion, might it not consider ways of delivering teaching and learning to its young people at or near to their homes, rather than have them travel to large schools? The need for peer group interaction as an essential part of learning implies that local learning facilities should be available within walking distance.

- When demographic changes lead to a fall in pupil numbers in a particular school and to the possibility of the closure of the school building, might it be possible to convert it into a community learning centre instead? New technologies could provide the learning materials for adults in the area, and at the same time, given suitable tutoring and counselling support, to provide a full and rich curriculum for the smaller number of children remaining. Australia and New Zealand, and rural parts of the United States are already demonstrating that taking learning to the people, instead of the people to learning, can be effective through the use of new technologies.

These ideas will all require co-operation between groups of people currently unused to working together. That will be an essential attribute of the new information-based society of the 21st century. They will also require considerable changes of attitude about both the amount of money put into the creation and delivery of learning materials (and about where money should come from — state or private sources) and also the role and numbers of teachers. Nevertheless their solution will be part of the societal changes which the mass use of the new technologies will bring about.

ii) Structures

Visits to educational buildings in France, Holland, Scotland and England in the course of this project have served to support — and to make more urgent — the thinking about the adaptability and flexibility of structures intended for educational purposes set out in the report of the Leicester PEB seminar.[2]

This means that:

- Structures should permit as much internal reorganisation as can reasonably be achieved. Experience with removable partition walls is not, so far, encouraging: some show signs of wear and looseness of fittings after only one or two moves.

- So far as is currently known, or research subsequently discovers, materials used in structures should offer as little resistance as possible to the short range transmission of radio and other electromagnetic signals within the building (used for wireless connections both for telecommunications and for data transmission between computers) as well as to reception from external sources.

- The main services provided should include access to telecommunications throughout the structure, as well as (for example) power, lighting, gas, water, and data networks. Power cabling should be adequately screened from data and telecommunications cables. Access to all services should be possible from all spaces.

- All services provided within a structure should be capable of computerised control, where appropriate, in order to achieve optimum environmental standards and economy of operation. "Smart buildings" will be the norm.

- Small buildings, or small units within larger structures, are to be preferred on grounds of flexibility of use, as well as of more human scale.

- The design concept for educational buildings, even those seen specifically as "schools", should allow for use by adults as well as children.

iii) Contents

The interior presentation of educational buildings, especially those which are specifically "schools", will need to give a different "feel":

- If a large proportion of the students are working as individuals or in small groups, there will be far more movement throughout the day than is currently the case. Noise reduction will therefore be important within learning spaces and in common parts.

- If attendance at the building is more open in terms of time, age range and purpose, then reception areas will not only need to be more welcoming, but will also need more space for administrative procedures, including "clocking-in and clocking-out" facilities (perhaps including "smart-card" readers). An electronic notice-board updated by computer will be required to give information about learning space availability. This could be linked to a learning-programme or work-station, booking procedure.

- If large, open-plan spaces are used for individual or small-group learning from computers, television, radio or telecommunications equipment, appropriate and effective psychological and acoustic screening will be required to avoid sound pollution across the whole space. Part of the acoustic problem could be solved by the use of light-weight headsets which, as a result of mass-market "Walkman"-type use should be easily and cheaply available. It could be expected that these would be students' personal property.

- It will be important for socialisation space to be provided. Whether the building, or the unit within a building, is large or small, the trend away from "whole-class" teaching will lead to a shifting group structure, and carefully planned spaces (and times) will be needed to allow for that peer-group socialisation which is itself an important element in the educational process.

- Space will also be needed for the different types of staff who will be working in the building.

  - Teachers will not only be engaged in the process of instruction. They will need areas in which to prepare their work, to carry out the administrative procedures related to it and to produce or amend learning materials. (Much will depend on a country's decisions about central, regional or local production of materials; but in any case, each institution will need at least to be able to amend, or compile,

materials from outside sources to suit the needs of its students.) This space will need adequate technological provision.

- Librarians and other information staff will need similar (perhaps the same) provision.
- Technical support staff will need adequately equipped workshops both for routine maintenance and for modification of equipment to keep it abreast of technological changes.
- Administrative staff — including those on reception or other "customer-service" work — also need appropriately equipped space.

It will be a matter for decision in individual projects whether the spaces described above will be needed in each educational building, or whether they can be provided in some local centre and networked to other buildings. In this connection, it should be remembered that in information-technology terms, physical distance does not prevent immediate access nor personal interaction.

- Where a building is intended for community use, or for use by children of widely differing ages, attention will need to be paid not only to the provision of furniture appropriate for different age-groups, but also to the "security" of the work of different groups of students. As an example, models made by first-school children are often fragile and large: adequate storage is needed if their working space is also used at other times of the day by teenagers or adults.

Provision specifically for the use of the new technologies will change in some significant ways:

- The "footprint" of computer equipment will be smaller than it is today. This will especially be the case in relation to visual display units if, as seems likely, flat-screen display devices become relatively cheap, and also if keyboards are replaced by voice input methods.
- The requirement for power cables to reach each piece of equipment will be less if a breakthrough is made in the development of lighter and more efficient rechargeable batteries. On current evidence this is a less likely development than some of the others referred to, and this prediction should therefore be treated with caution. However, if it does occur, new provision must be made for the recharging of batteries.
- There will be less need for network cabling within learning spaces, as the provision for wireless connections develops. This does not however reduce the need for network cabling between learning spaces and throughout the building, which remains important. Cable management is likely to become less of a problem within a particular learning space than it is today.
- There will need to be access to telecommunications systems from all learning spaces. Again, this is an area in which the line of development is not only presently unclear, but will also vary according to different countries' decisions about telecommunications policy. If there is strong pressure towards developing cordless and microcellular, radio telephones (as seems likely, for example, in the United Kingdom), and if there is a related development of suitable computer interface cards, as is almost inevitable, then it will only be necessary to provide a hard-wired telephone point in each learning space — or even on each floor of a building — in order to provide access from each microcomputer, fax machine, or portable telephone. If, on the other hand, national policy

favours a fully cabled system, then direct wire connections with equipment will be necessary.

- Access to broadband cable, either related to satellite broadcasting, or to city-wide cable networks, must be hard-wired. Here it is important that access points are not located in such a way as to reinforce "teacher-before-a-class" concepts; that is, only at the back or front of a learning space. The use of broadband systems will be interactive in many cases and it may be necessary for equipment to be attached to the system at various times and various places by different people. The positioning of these types of input/output points is an example of decisions which will need careful (and perhaps ongoing) discussion between architect and users throughout the development of a new, or adapted building.

- Health and safety matters will need constant attention as the use of information technology in society as a whole develops. So far as educational buildings are concerned, matters of lighting and heating, exposure to electromagnetic radiation, and postural problems related to appropriateness of seating and other furniture can all be dealt with by reference to experience in industrial and commercial circumstances. It should also be noted, however, that if the developments which I have predicted in the use of non-educational buildings come about, then health and safety factors will need to be reconsidered in relation to the use of the accommodation by young people, rather than adults.

- It may be that, in twenty years' time, security for large quantities of sophisticated, electronic equipment will not be such a problem as it is now. As the equipment becomes more common in all aspects of working, home and leisure life, theft of individual items will be far less attractive. More likely, however, will be the development of security systems which are themselves electronic and will ensure that any unauthorised removal of a piece of equipment from its "security-registered" place will automatically set off an alarm. The use of educational buildings for much greater parts of the day (resulting from community use and more open-access concepts for all students) may also tend to reduce opportunities for break-in and theft.

Notes and references

1. The reports of these seminars have been published by PEB under the following titles:

   Building Implications of New Information Technology, Conclusions of a Seminar in Dunblane, Scotland, 23-27 September 1985 by James Linn and Martin Garden.

   Schools as Part of a Network of Learning Facilities — Implications for Educational Building, Conclusions of a Symposium in Segovia, Spain, 1-4 December 1986 by James Linn.

   Adaptability and Flexibility in Educational Facilities, Conclusions of a Seminar held in Leicester, United Kingdom, 19-22 June 1989 by Roger Clynes.

2. Clynes, ibid.

V. CONCLUSIONS

The purpose of the Rochefort seminar was to open the minds of those who attended to the possibilities, and the problems, which the pervasive influence of new information technologies will put before everyone involved in the provision of educational facilities in the early years of the twenty-first century. It was not, therefore, a seminar which could come up with a set of conclusions or recommendations. It was, rather, an opportunity to discover what countries are doing and to begin to speculate about the way things will develop in a future which is all too imminent.

The different contexts, in terms of practice and culture, in which the various countries' representatives spend their working lives meant that all came to the seminar looking for different things. Each participant no doubt drew different conclusions from the experiences presented. But a number of matters raised in the seminar can be drawn out as points on which all participants would say they agreed.

Participants in the seminar were allocated to working groups, each of which contained a mix of nationalities.

Each group was left free to decide how it handled discussion of the following questions:

- What, in the group's opinion, are likely to be the major technical, social and cultural challenges facing designers of educational buildings in the next twenty years?
- In what ways might education, and especially the curriculum and the methods used to deliver it, change to meet these new demands?
- What will be the impact of these changes on the role and professional standing of teachers; for example in the preparation of self-teaching materials, the relationship with individual students, and the sharing of tasks with other professionals and support staff?
- What are the advantages and disadvantages of individually tailored learning methods — for students and teachers — and for those who run the system?
- Where should learning take place? Will the present concept of "school" as a place essentially separate from other social and economic activity continue to be appropriate?
- What will be the consequences of change for the design and structure of buildings used for educational purposes and for their furniture and equipment?
- What will be the implications of these demands for the siting and accessibility of buildings and for interconnections between buildings and between "schools"?

Because not all groups covered all the questions, and because the discussions in the groups followed different paths depending on the style of chairmanship and the national make-up of the group, the summary of the discussions which follows uses three general headings:

i) The interface between technology, education and society;

ii) Changes within the structures and methods of education;

iii) Changes in educational buildings.

i) The interface between technology, education and society

The introduction of new technologies, not only in education but in society at large, poses the same general problems in all countries. The problems are related to cost, and to the level at which decisions are taken. But at a deeper level they are also related to social and cultural attitudes and expectations and this makes consensus very difficult to achieve in an international forum. One point, however, which came out very strongly in all the discussions was the need for equity.

It is important that no group within a nation is, for any reason, excluded from access to the benefits which new technologies can bring. Because of this, special efforts will be needed to ensure provision for the disabled and the disadvantaged. This will not only include, for example, the poor and those living in deprived areas of cities, but also those who live in rural or isolated communities who may not be poor in financial terms but will need protection from "information poverty".

The influence of technology on society at large will produce many challenges which will have implications at a cultural as well as an educational level. The trend in employment towards a general demand for a more educated workforce, within societies which are becoming more culturally heterogeneous, will have an effect not only on the structure, methods and place of teaching and learning, but also on political decisions about access to higher education. Related to this will be a shift in the pattern of decision-taking about the need for learning, away from government and society and towards the individual. Far more responsibility will devolve onto individual citizens to ensure that, throughout their lives, opportunities are taken to maintain a level of education and training appropriate to their working and social environment. Society's role will be to provide those opportunities.

A clear warning was given to beware of fashions in the introduction of new technologies. Many cases of the provision of technological tools for education were the result of political or financial decisions, rather than educational ones, with the result that teachers were not properly prepared for their introduction — nor sometimes even convinced of their usefulness. Indeed, it has often been the case, and will continue to be so, that new technologies have been introduced into education to solve non-educational problems; for example to give governments a modern image or, as in the example of the Tilburg experiment cited above, to deal with a pressing environmental problem. The role of private industry in the introduction of technology into education was also mentioned: although this will vary greatly from country to country and is expected to be an increasing influence in the future, questions sometimes need to be asked about the motives underlying industry's involvement.

There is also a danger of manipulation. I pointed out, earlier, the extent to which the new technologies make the walls of the learning space "transparent", providing a freedom for the learner to explore sources of information outside his institution, even outside his country. But there is another side to the use of new technologies which needs to be recognised. They can easily be used — consciously or unconsciously — as methods of control. He who writes the software controls the thinking of the user. How many of us know what parameters have been set within a program? Or know how to find out? That problem will become even more serious when the powerful artificial intelligence programs of the future begin to "learn" from their users. The high cost of producing learning materials in some of the new multi-media systems

means that a few major producers are likely to supply much of the market: enormous power will be available to them, and safeguards will be necessary to ensure that it is not abused.

ii) Changes within the structures and methods of education

All the groups expressed the firm belief that school, in some form or other, will always have a role in the education of young people and in the development of society. There can be no true education without contact between pupils and teachers and between pupils themselves. A major element of education, as opposed to the mere gathering of knowledge, lies in the social contacts and development of interpersonal relationships which occur within the structure of school life and which are an indispensable part of preparation for later life. Whilst it is possible for an isolated individual, through the new technologies, to obtain information and even knowledge, true education requires an element of social contact.

Allied to this was confirmation of the essential and continuing role of the teacher in the educational process. That this role will change under the influence of the new technologies is certain (and is referred to in more detail below), but the point was made strongly that teachers are essential to the learning process, it is they who teach the students "the world behind the facts".

Individualisation of learning

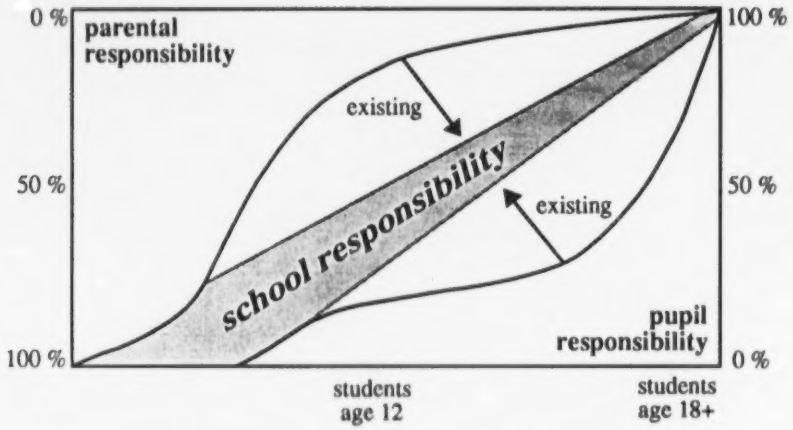
The change in the role and status of teachers will be affected as much by the move towards individualised learning methods now made practicable by the use of new technology, as they will by the "opening up" of the classroom to outside influences which technology brings about. It has to be recognised that "the autonomy of learners" is a concept with which some educators will find it hard to cope. The extent to which the move towards individualisation of learning will take place and the speed with which it will occur were the subject of disagreement. Whilst some felt that it will occur only slowly, and that some subjects were not appropriate at all for individualised instruction, others felt that the change would come rapidly and would be a major engine for change in the education system. Nevertheless all agreed that there will be a move towards more individual and small group work, and more co-operative work between pupils. This will lead to a breaking down of the conventional class organisation in schools, with consequent implications for the provision of learning spaces and, equally significantly, for the way in which school time is organised (a matter which must be considered by those who manage educational systems).

The implications of individualised learning methods for personal responsibility towards learning attracted serious debate. One group attempted to express in graphical form the way in which the present responsibility of the school for deciding what a student should learn, as related to the responsibility of the parent and of the student, would be "squeezed" by the influence both of learning facilities in the home and by the growing responsibility of the student for making his or her own "learning contract". That diagram is reproduced as Figure 1.

The role and status of teachers

There was also a good deal of discussion on the ways in which the pervasive use of new technologies would affect the role and status of teachers. It was suggested that the most significant consequence for them will be a heavier load of preparation. The

Figure 1



information they handle will become more complex and they will need to learn rapidly themselves. There will be a greater need for them to prepare and adapt a wide variety of learning materials for use by individual students. (It was noted in passing that there is a need for some international solution to the problem of copyright in audio-visual and computer-based materials.)

One consequence of this will be the need for teachers to have more space in schools for their own work — perhaps having their own offices. They will need to work more closely, and more co-operatively, with colleagues (in some circumstances developing team-teaching methods) and there will be more frequent contacts with professionals outside their own establishments. Changed relationships with their pupils will mean teachers will have to manage their time so that they are more able to spend time with individual pupils in a tutorial relationship.

It will not be easy for teachers to cope with these changing roles and relationships, and as a profession they will need to see some benefit from the changes, even if this is only in the shape of more space in which to work within the school building. Interestingly, it was stressed that money alone would not solve the crisis in morale in the profession mentioned by many participants. It is particularly important that a divide should not be allowed to develop between those teachers who are comfortable with the new technologies, and those, perhaps especially older teachers, who find the new technologies less attractive. Again the benefits of a co-operative, team-teaching approach may help alleviate this problem.

Training and re-training of teaching and other support staff will be very important, though there was some disagreement about the part to be played in this by the "technological enthusiasts" amongst the staff. Some members thought they should be encouraged to act as "resource people" for their colleagues, whilst others warned of the dangers of enthusiasts using new techniques without sufficient knowledge of their long-term effects: educational experiments cannot be carried out in a vacuum, and affect people's lives.

For the benefit of teachers, pupils and administrative staff, it is felt that there should be an obligation on every school to define its policy for the introduction and use of new technologies.

The school in its community

The importance of the school as a focus for educational activity within a community was discussed at some length. There was disagreement between those who argued that "school" was, and should remain, a social and cultural centre for the community, integrated with its economic and cultural life, and those who argued for the creation of a "community learning facility"; but this disagreement was perhaps more apparent than real. The main difference between the two views does not concern the functions that will need to be fulfilled — over which there was broad agreement — but rather the value to be attached to the school as a cultural symbol: the second group seeing the practicalities of access to learning as of greater importance than the status of the building itself.

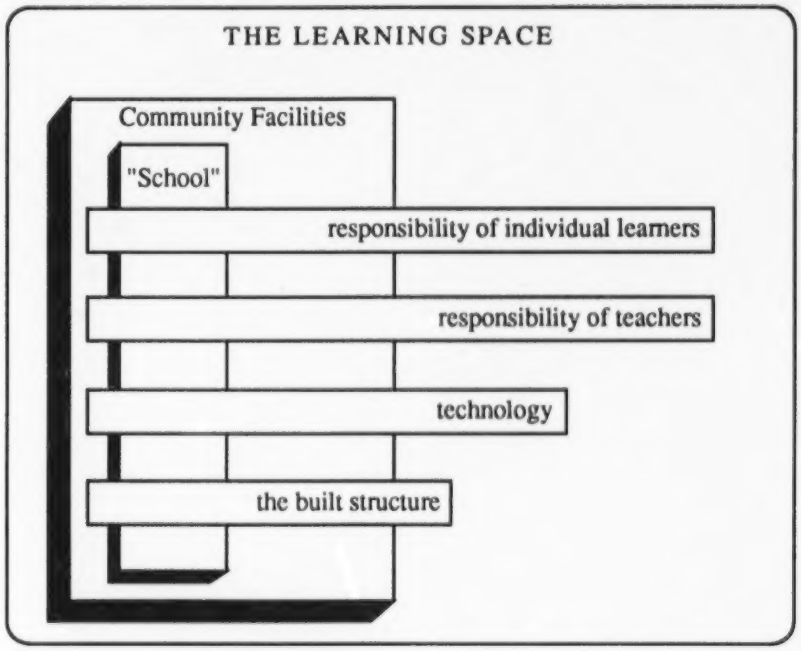
Everyone agreed that there will always be a need for some defined place where people meet to learn. No-one wished to see the development of what one group called "totally isolated learning". Some social contact was seen as essential to true education.

Nevertheless there was recognition by all groups that there are powerful economic and technological arguments in favour of multi-use buildings, which of themselves raise further problems relating to legal responsibilities, apportionment of costs, social and political control, and access. The solution of such problems will depend on the climate of opinion in the country and community concerned, and on the extent to which consultation with and involvement of the local community is encouraged. If schools are to become, as most seminar participants agreed they should, part of a wider community resource which, through the use of new technology, would allow the whole community, including marginalised groups, to have easy access to knowledge and to training, they would need to be owned by the community — something which would change not only local interest in the school but also its design (which would no longer be dictated "by some distant bureaucrat").

Where such communities were in rural or isolated areas, and the school was being provided with new technology as a means of maintaining a full learning facility for all the people (not just for children), local or national government would almost certainly need to provide special financial support, especially for the communications costs. Several groups stressed the way in which new technologies could help to retain a full standard of life in rural communities.

One group produced the following diagram as a way of expressing the broad concept of the components of the "learning space" in a situation in which the new information technologies were widespread throughout a community's life. Most of working and domestic life would provide opportunities for learning, but within this would be formally provided community facilities — as described above — one of which would be the "school", however defined. Within those community facilities lie four elements which must between them formulate an "equity contract" in order to ensure that no sections of the community are debarred or disadvantaged. Each of the four elements — the individual learner (child or adult), the teacher or provider, the technology, and the built structure — has a varying amount of responsibility for ensuring that there is equity of provision (Figure 2).

Figure 2: The Equity Contract



iii) Changes in educational buildings

Despite the many different reservations expressed during the group discussions, all members agreed that the impact of the new technologies on education would lead to significant changes in the functions of various areas in school buildings. Reference has been made earlier to the extra space required by the increased movement of pupils and staff involved in individualised instruction. More space would also be needed for such facilities as library/resource areas, socialisation spaces, technical workshops and specialised spaces for the preparation of learning materials. This led one group to suggest that standards laid down by governments relating to, for example, floor area per student will need to be reviewed frequently, and may even have become irrelevant.

The very rapid pace of technological change means that all buildings designed for learning purposes must be remodellable without the need for reconstruction. Designs must aim to produce a building which can evolve in response to changing needs, a situation which requires a continuing dialogue between educators, technical specialists and architects. Specific materials and equipment should only be provided for well-defined needs, for which the staff of the institution have already been or can easily be trained.

The needs of communication technologies must be considered right from the start of building design so that, for example,

cabling is provided on the periphery of large, open spaces which are free of load-bearing walls, to make it easier to adapt computer and telecommunications networks to the changing spaces and the uses for which they are required. The possibility of data and telecommunications networking between educational buildings should be considered in all new planning.

A basic model for an educational building might be seen as involving a "hub" — a community-based centre for various learning resources — around which are facilities which can be easily adapted to a variety of uses. The architecture of such a building would need, firstly, to be welcoming to new, as well as to existing types of students (often involving adults as well as young people), to express and to facilitate the new learning methods which it contained, and thirdly to indicate its "openness" to the community and the wider world. In this connection, it was noted that, because of the impact of new technologies, there is now far less difference than there once was between the design of educational buildings and that of buildings intended for other purposes.

Costing presents a very real problem. There will be claim and counter-claim about the cost and the cost-effectiveness of applying the new technologies to education and training. Over the past twenty years the Council for Educational Technology for the United Kingdom, among others, has made several efforts at creating a structure for costing educational practice which could produce clear comparisons between the costs of what are called "traditional" methods and those based on using new technologies. Their problem was always that no-one would be precise about the output from the educational experience which was to be measured. Without being sure of the desired output, it is impossible to measure the effectiveness of the inputs. It is equally important to ask — particularly of those who claim that the cost of applying the new technologies will be too high — what will be the economic cost of not applying them? This is also a warning to those who will claim that the use of a particular new technology will reduce the cost of education.

The budget for the building must make adequate provision for the maintenance of the structure and for the equipment and facilities it contains: it is suggested that the relationship between initial costs and running costs should be reconsidered, so that any savings made in the initial construction could be set aside for subsequent maintenance.

VI. AFTERWORD

Perhaps the best summary of the seminar discussions would be that written by one of the working groups. In a world of new technologies:

> *Learning will become a more diverse networked activity for all ages of student, and only part of it will take place in permanent community facilities designed to provide a social and resources focus in the form of a welcoming and technologically democratic architecture.*

To that, I would add that new information technologies can, used sensibly and appropriately, and provided equitably, free the learner and the teacher from the confines of a single space. The technical characteristics of the equipment can be ignored for the future, because it will almost certainly be small, light, easy-to-use material generally available in society. But architects and planners must nevertheless keep in constant touch with research and development in this field, because much will occur rapidly to overcome the present problems and allow communication and access to information — those symbols of power in the 21st century — to be available and used by all our citizens.

Otto Peters, the first *Rektor* of the German *Fernuniversität* (distance teaching university) wrote in 1989:

> *The industrialisation of teaching and learning is only a small part of a pattern of enormous social change. Industrialisation has changed and will go on changing our lives fundamentally whether we like it or not: people now work, spend their leisure time, buy, eat and communicate with their relatives and friends in different ways. They also think in different ways and have developed attitudes not known by their grandparents. It is unlikely that education can resist this process.*[1]

The industrialisation to which Peters refers is now moving into an even more powerful post-industrial, information-based era. The pace and impact of change will increase greatly over the next twenty years and it is essential for the economic success and social stability of OECD countries that educators embrace, assist, and become an integral part of that change. We have to prepare our young people for life in a 21st-century society in which they will "spend their leisure time, buy, eat and communicate" in ways which and with attitudes which we cannot currently conceive. We have to build the skills of adaptability to a context of permanent change into the foundations of our educational provision — and of the buildings in which it takes place.

Notes and references

1. Otto Peters, article in *Open Learning*, November 1989.

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